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RESEARCH IN ADAPTIVE CONTROL - HYBRID AND CONSTRAINED STRUCTURE--ETC(U)
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RESEARCH IN ADAPTIVE CONTROL -
HYBRID AND CONSTRAINED STRUCTURE SYSTEMS

(May 1, 1981 through April 30, 1982)

Report Number AFOSR-80-0155-SA1

by

T. E. Djaferis, Co-Principal Investigator
(The late R. V. Monopoli, Principal Investigator)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Research results in Hybrid Model Reference Adaptive Control Systems (HMRACS) are reported. Two stable hybrid adaptive algorithms are given for gain adjustment with periodic or variable rate sampling. The hybrid approach holds promise for more robust designs in the presence of unmodelled dynamics. New pole assignment methods using dynamic output feedback are discussed that improve earlier results and which may in addition lead to simpler adaptive algorithms.		

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I. RESEARCH OBJECTIVES

In recent years, due to the efforts of many researchers in the field, several very important theoretical issues concerning the stability of Adaptive Control Systems have been resolved, making Adaptive Control a viable alternative design technique. However if there is to be a wider acceptance and applicability of Adaptive Control, other important issues such as rate of convergence, robustness, computational complexity, plant requirements, have to be addressed. The objective of this research has been to continue the effort towards improving the performance of Model Reference Adaptive Control Systems (MRACS) by investigating Hybrid and Constrained structure systems. The specific objectives were:

- 1) To develop stable Hybrid Model Reference Adaptive Control Systems (HMRACS).
- 2) To investigate the robustness of these systems in the presence of unmodelled dynamics.
- 3) To investigate how constraints on the structure of these systems can simplify existing adaptive control algorithms allowing for an easier implementation.



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II. STATUS OF RESEARCH

The concept of Model Reference Adaptive Control has been developed for continuous and discrete time systems. In continuous time systems the gain adjustment algorithm runs in continuous time whereas in discrete time systems the adjustment of gains is done in discrete time. It is only recently that attempts have been directed towards developing a "Hybrid" approach. In Hybrid Model Reference Adaptive Control Systems (HMRACS) the adaptive gains for a continuous time system are adjusted on a discrete time basis. Reasons for this investigation include a) convenience of implementation by performing calculations on a digital computer and using multiplying DAC's (digital to analog converters) and b) possible improved robustness of the system in the presence of unmodelled dynamics. References [1] and [2] include two different solutions to the Hybrid Model Reference Problem. Both guarantee stability of the overall system. In the first scheme [1] the continuous time system is periodically sampled at a frequency F and a bound F^* is given in such a way that the closed loop system is stable whenever $F > F^*$. In the second scheme [2] the system is sampled at a variable rate varying with the magnitude of the error. This effort represents a successful answer to research objective I-1. In addition to the theoretical results, a real time hardware implementation has been carried out for a DC servomotor using the Intel 8086 sixteen bit microprocessor.

Work on objective I-2 (Robustness) is continuing. Initial simulation results have been encouraging and the whole question is presently under investigation. A concrete Theoretical justification is sought.

Existing Model Reference Adaptive Control System designs are adaptive implementations of model following schemes for systems with known parameters. One way of improving the performance of these designs (and simplify the algorithms) is to first suggest simpler solutions to the algebraic problem (known parameters case) and then construct an adaptive implementation which guarantees stability. Work in this area (addressing objective I-3) is reported in [3] where the problem of pole assignment is considered when the order of the compensator is fixed. This work represents an improvement over existing results on the problem. Research is continuing along these lines [4] and the method used in our approach shows the potential of being applied to pole assignment over rings, stabilization, and being used for robust system designs, in addition to Model Reference Adaptive Control. Reference [5] contains some results on the related problem of Invariant Factor Assignment.

III. PUBLICATIONS

Reference [3] has been accepted for publication in the International Journal of Control (and has been presented at the 19th Allerton Conference). Reference [1] has been submitted for publication in the IEEE Trans. on A.C. and for presentation at the 1982 Decision and Control Conference. Reference [2] has been presented to the 1982 American Control Conference. Reference [4] has been submitted for presentation at the 1982 Decision and Control Conference and Reference [5] has been submitted for publication to Linear Algebra and its Applications special issue on Linear Control Theory. Copies of the papers mentioned above are included in this report.

IV. ASSOCIATED PROFESSIONAL PERSONNEL

Our University community and the School of Engineering in particular has been deeply saddened by the tragic and unexpected death of Professor Richard V. Monopoli. He has served the Department of Electrical and Computer Engineering with distinction and played a major role in its progressive development. He was a devoted teacher, researcher and family man. We have all lost an excellent colleague and friend.

Professor Monopoli was the Principal Investigator for this research effort. Professor Theodore E. Djaferis is the Co-Principal Investigator. Two graduate students, one a Ph.D. candidate and the other an M.Sc. candidate have worked on the project.

REFERENCES

1. R. Cristi and R. V. Monopoli, "A Stable Hybrid Adaptive Algorithm with Periodic Sampling and Gain Adjustment" submitted for publication in the IEEE Trans. on A.C. and for presentation at the 21st Decision and Control Conference, Orlando, Florida, December 1982.
2. R. Cristi and R. V. Monopoli, "Model Reference Adaptive Control Systems: The Hybrid Approach," presented at the 1982 American Control Conference, Arlington, Virginia, June 1982.
3. T. E. Djaferis, "Generic Pole Assignment Using Dynamic Output Feedback," to appear in the International Journal of Control.
4. T. E. Djaferis, "Another Approach to Generic Pole Assignment," submitted for presentation to the 21st Decision and Control Conference, Orlando, Florida, December 1982.
5. T. E. Djaferis and S. K. Mitter, "Some Generic Invariant Factor Results Using Dynamic Output Feedback," submitted for publication to Linear Algebra and Its Applications special issue on Linear Control Theory.